

Cost for Large Liquid Scintillator Detector

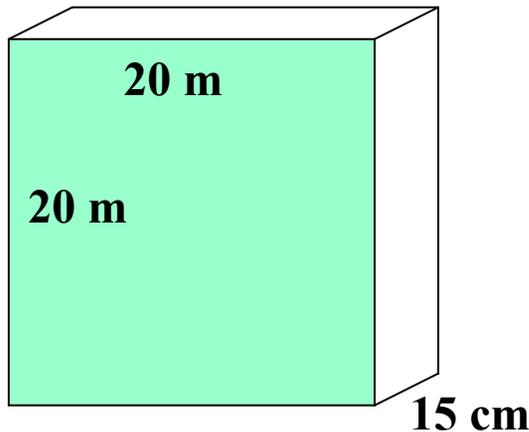
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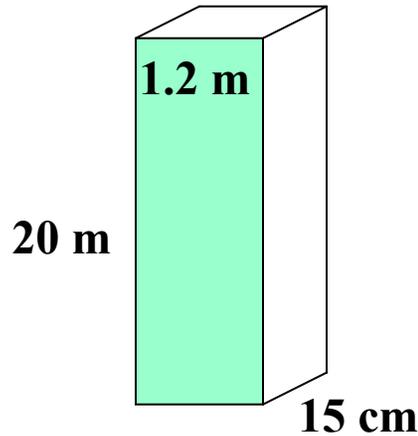
- **Active Detector – Liquid Scintillator**
- **Target Material - Water**
- **Read Out – Wavelength Shifting Fiber**
- **Photodetector – Image Intensifier + ccd camera**
- **Structure – PVC Extrusions**

Detector cost - \$1M/kTon

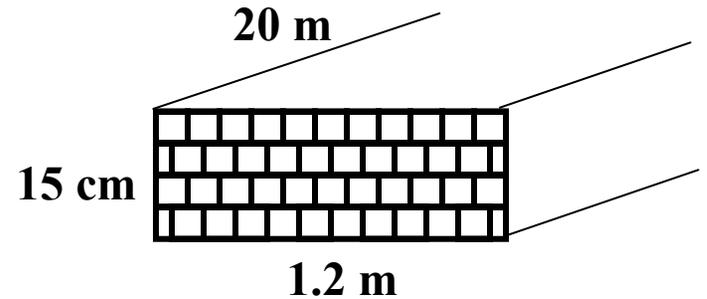
Design for Costing – PVC Structure



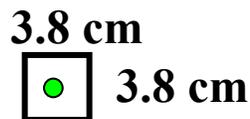
312 planes
64 Tons/plane
48 Tons water
16 Tons scintillator
15.6 planes/kTon



16 modules/plane
4 Tons/module
3 Tons water
1 Ton scintillator



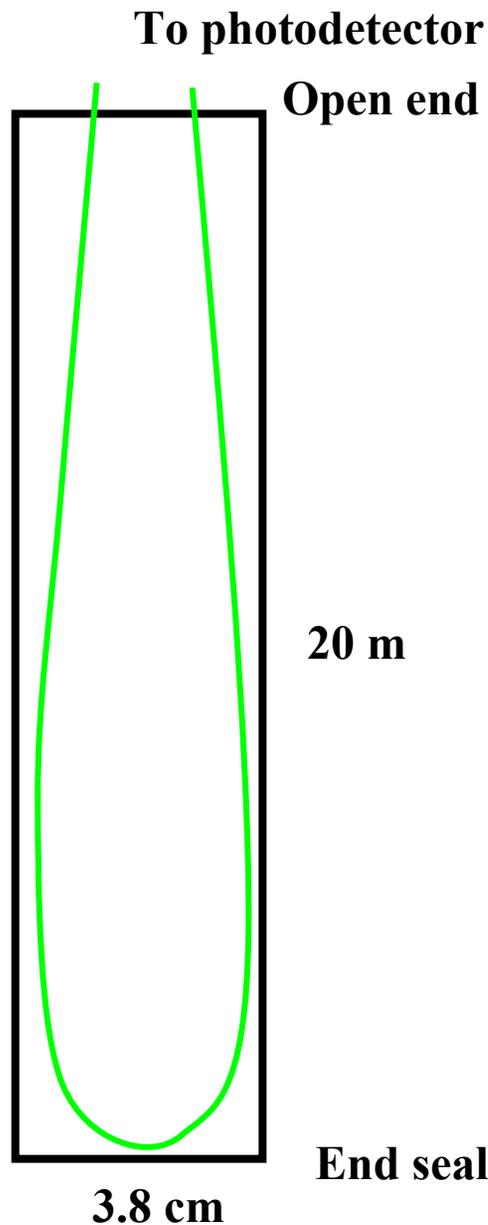
4 layers/module
32 cells/layer
Single PVC extrusion
3 Layers water
1 Layer scintillator
392 lbs/module (unfilled)



32 cells/layer
1.5 mm outer wall
1 mm inner wall
WLS read out for scintillator

512 cells/plane
8000 cells/kTon

Design for Costing – Wavelength Shifting Fiber



22 m WLS fiber/scintillator cell

0.5 mm diameter fiber

6 m attenuation length

U gives

2 x light of single fiber near photodetector

4 x light of single fiber at far end

Light trapped as r

Fiber cost as r^2

0.5 mm U fiber gives

2 x light of a single 1mm fiber (far end) at $\frac{1}{2}$ the cost

Budget

Scintillator –

Fluor in mineral oil concentrate
mix at site with

Mineral oil to dilute to B517L

\$1.65M/kTon of scintillator

16 Tons scintillator/plane

\$26.4k/plane = \$66/m²

Scintillator is ¼ of detector mass

\$412k/kTon detector

PVC extrusions –

\$1.07/lb

392 lbs/module

16 modules/plane

\$6.7k/plane = \$16.8/m²

15.6 planes/kTon

\$105k/kTon detector

+ one time die cost \$200k

WLS Fiber 0.5mm –

\$0.75/m

44 m/fiber

512 fibers/plane

\$17k/plane = \$42.5/m²

8000 fibers/kTon

\$264k/kTon detector

Manifolds –

\$200/module

16 modules/plane

\$3.2k/plane = \$8/m²

15.6 planes/kTon

\$50k/kTon detector

Other Costs

Photodetector IIT (2 cm x 1.5 cm)

\$2500 each including CCD camera and optics

1 IIT per plane (1024 fiber ends) 2/3 IIT area

\$2.5k/plane = \$6.25/m²

15.6 planes/kTon

\$39k/kTon

Clear Fiber (4 modules on 4 planes to IIT)

4 m clear fiber/wls end x 1024 wls ends = 4096 m

\$0.75/m

\$3.1k/plane = \$7.68/m²

15.6 planes/kTon

\$48k/kTon

Installation

Transport and stack light-weight modules (392 lbs)

Fill on site

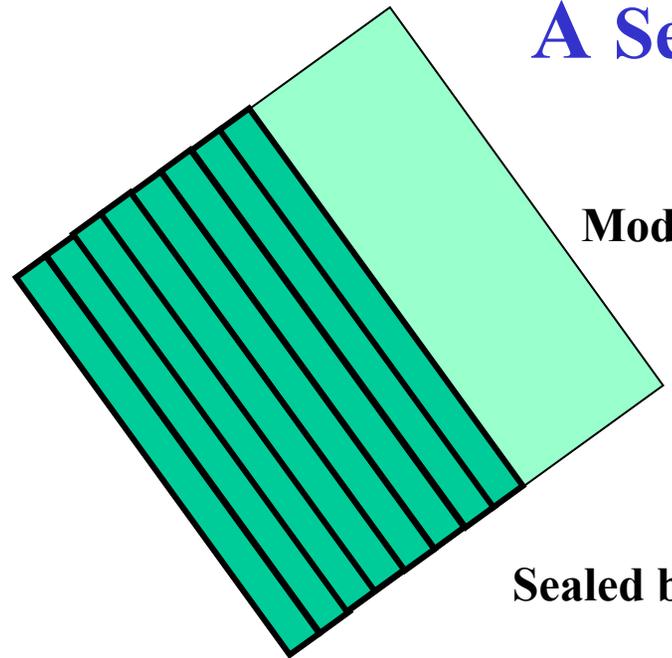
64 man hours/plane - **\$1.6k/plane = \$4/m²**

15.6 planes/kTon

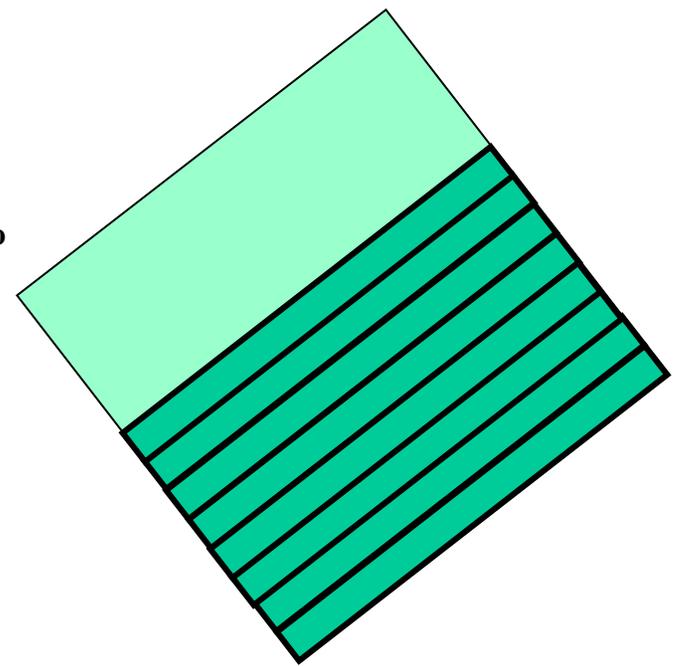
\$25k/kTon

A Self Supporting Structure

Modules at alternating at 45°

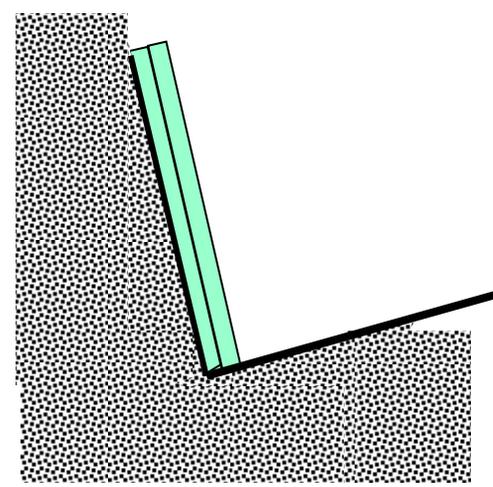
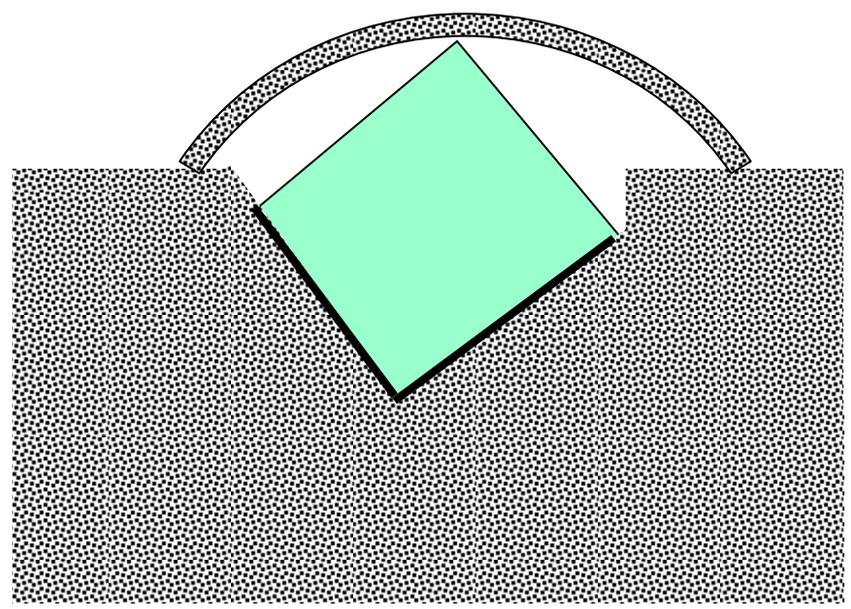


Sealed bottoms



Front view

Side view



1° slope

Cost Summary

	Per m ²	Per plane	Per kTon
Scintillator	\$66	\$26.4k	\$412k
WLS Fiber	\$42.5	\$17k	\$264k
PVC extrusions	\$16.8	\$ 6.7k	\$105k
Manifolds	\$ 8	\$ 3.2k	\$ 50k
Photodetector + electronics	\$ 6.3	\$ 2.5k	\$ 39k
Clear Fiber	\$ 7.7	\$ 3.1k	\$ 48k
Installation	\$ 4	\$ 1.6k	\$ 25k
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Total	\$151	\$60.4k	\$943k

Not included: DAQ, trigger electronics, water, fiber coupling to IIT, QA, cosmic ray shield, calibration, pumps, hoists, site, power, safety, heating, cooling

A 20kTon liquid scintillator detector costs \$20M + site + outfitting

Can build with current technology at reasonable price

Liquid vs Solid for 20kt with water absorber

(\$M)	Solid	Liquid
Scintillator	15.8	8.2
Container/module	11.2	2.1
Small parts	Above	1.0
WLS fiber	6.0	5.2
IIT + housing + cable	2.9	2.1
Absorber	2.1	above
Installation	1.0	0.5
\$/Area (m²)		154
Total (20 kTons)	39.0	19.1

Added flexibility of liquid scintillator design
Change fraction or nature of absorber